



**INSA**

INSTITUT NATIONAL  
DES SCIENCES  
APPLIQUÉES  
ROUEN



# Mathematical Modeling and NUMerical simulation

## M<sup>2</sup>NUM

203

203.5



204

20.6

20.



# The Project



# M<sup>2</sup>NUM

The core of **M<sup>2</sup>NUM** project (N. Forcadel & C. Le Guyader, LMI EA3226) rests upon the **mathematical modeling of problems stemming from different applications**. The proposed new models will be considered through the use of partial differential equations: this field of investigations receives a great deal of attention in Normandy and echoes back to the applications related to regional priorities, namely:

- **Imaging sciences**,
- **Energy, wind power, approximation of wind velocity field**,
- **Road traffic, eco-mobility, embedded systems...**
- **Physics and mechanics** (soon)

In this project, we focus on **various theoretical aspects** (existence and uniqueness of a solution, convergence results, control, homogenization) as well as **more applied ones** (finite difference scheme based discretization, finite volume scheme based discretization or finite element based one) to design algorithms that are then implemented ( we have links with the Centre de Ressources Informatiques de Haute-Normandie (**CRIHAN**) which deploys high-performance computing infrastructures allowing for the processing of large volume data). The project objectives and priorities meet the expectations and criteria included in all strategic documents for the upcoming years: SRESRI (Higher Education Regional Plan for Research and Innovation of Haute-Normandie) (CPER Contract Plan State-Region), the ERDF operational program (in accordance with the Strategy for Research and Innovation based on a **Smart Specialisation** (SRI – SI)). The project M<sup>2</sup>NUM is also in the spirit of the National Strategy for Research (Challenge 7 : Information society and communication and Challenge 8 : Innovative, integrative and adaptive societies). The **M<sup>2</sup>NUM** project was launched in 2014 and will be running until 2018.

The goal is to provide demonstrators and tools accessible to the community. The core of this project perfectly matches the line 4 entitled **Numerical Computations of the Grand Réseau de Recherche, Logistique, Mobilité, Numérique** (GRR LMN).

It is related to the sub-themes :

- *Numerical processing for life or environmental sciences ;*
- *Asymptotic and stochastic modeling, control and reliability ;*
- *Simulations and numerical performance, linked to the computational center CRIHAN (Rouen).*

PhD grants, postdocs, research engineer grants and engineering courses are included in the funding plan.



## GOALS

The project objectives are related to advances both in fundamental research and in technological research. The practical applications are clearly identified and the expected consequences of the project fall within :

- industrial applications,
- academic results,
- local, national and international developments

## PUBLICATIONS & CONFERENCES

Three options are considered

- Articles in international journals,
- Communications in international conferences,
- Communications/seminars dedicated to students.

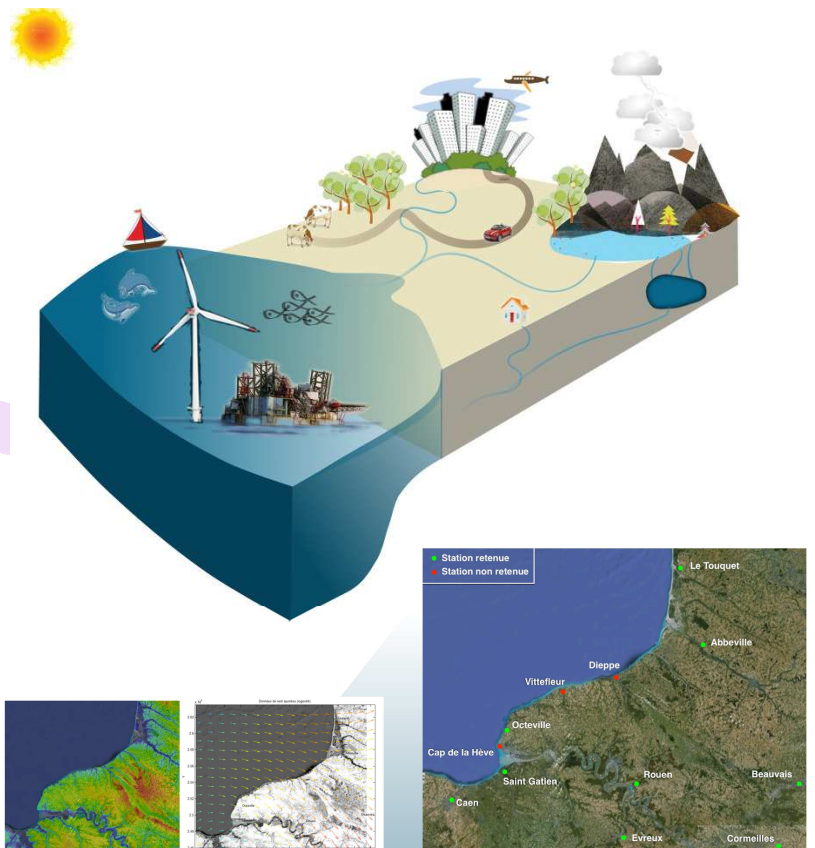
The M<sup>2</sup>NUM project has already obtained a First Conference Prize at the National Conference Curves and Surfaces (2014).

## WORKSHOPS

Every year, M<sup>2</sup>NUM workshops and special days are organized, with the participation of international researchers :

- High-Performance Computing/ Parallel Computing days.
- Imaging Sciences days : in collaboration with the Fédérations de recherche normandes Normandie Mathématiques and Normastic, the GDR IG and the Labex AMIES.
- Road Traffic days.

## AN EARTH-OCEAN CONTINUUM



## The Project e@lin with the Labex AMIES

### Approximation of wind velocity field from Lagrange data

The project **e@lin** has been developed in line with the M2NUM project. This explorative project is funded by the Labex AMIES, in connection with the Compagnie du Vent (Groupe GDF SUEZ). It proved to be an incentive to setting up the M2NUM project.



Agence pour les mathématiques en interaction avec l'entreprise et la société

The starting point of this work is the assumption that the wind velocity field derives from a potential (e.g. the temperature for the wind). This problem occurs for instance in electromagnetism, meteorology, medical imaging or radar image analysis. In this study, we do not aim to compute explicitly this potential from which we could deduce the wind velocity field. We only aim to obtain a global approximation of the wind velocity field on a bounded domain, taking into account, in the modeling, that this field derives from a potential. The data are, for example, the knowledge of the wind velocity field at a finite number of loci (weather stations, anemometers ...)

**AMIES** (<http://www.agence-maths-entreprises.fr>)

## ZOOM ON THE COMPANIES AND RESEARCH STRUCTURES THAT TRUST US

### AREVA WIND (soon)

In relationship with the CORIA, numerical simulations of wake and whirl effects at the level of the blades

### Labex AMIES

e@olin, project related to the Compagnie du Vent

### AREELIS (soon)

Phase-change materials

### CEREMA

Imaging from high resolution images and road traffic

### ORANGE (soon)

Thermal regulation of telecommunication cabinets

### CORIA

Numerical simulations

### LITIS

Medical imaging and embedded systems

### IRSEEM (soon)

Embedded systems

### LMAH

PDE

### GDF SUEZ – La Compagnie du Vent

Approximation of wind velocity field, data visualization

### LMRS

Imaging sciences and phase-change materials

### INRIA EPI MAGIQUE3D

Seismic imaging and numerical simulations

### TOTAL

3D Seismic imaging. In relationship with EPI MAGIQUE 3D (INRIA Bordeaux South West)

### LMI [Project holder]

Imaging sciences, wind power, road traffic, modeling and numerical simulations

## The Grands Réseaux de Recherche de Haute Normandie



**A. Chisliac**  
GRR coordinator  
(INSA, UR, ULH)

The goal of GRR is to bring together the resources from the European Union, from the French State and from the Région Haute-Normandie, in order to strengthen the relations between the different involved collaborators, and institute optimal working conditions in the service of performance. The Grands Réseaux de Recherche promote interdisciplinarity, trans-laboratories and inter-institutions. The five GRR are: CBH (Chemistry, Biology, Health), NCS (Normandy Culture and Society), EEM (Energy, Electronics & Materials), LMDT (Logistics, Mobility, Digital Technology) and TERA (Territory, Environment, Risk, Agronomics).

## Valuation and Intellectual Property INSA de Rouen



**S. Vander Eecken**  
Dir. Research and Valorization  
INSA

The questions of protecting the interests of an institution and its researchers' as regards intellectual property, contracts, technology transfers from academical research to socio-economic world, detection of valuable knowledge, patent registration and management, setting up startups, are dealt with by the Research and Promotion Management of the INSA Rouen.

Reference :

D. Vaquez et S. Vander Eecken, *Valorisation et propriété industrielle*, Matapli (106), pp. 81—88, 2015

## Laboratories and Normandy institutions taking part in the project



**The M<sup>2</sup>NUM TEAM** (2015)



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